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ABSTRACT

This unit is one of a series in environmental education for grades 1-12. The unit is designed to be used with secondary school students and includes the following sections: (1) Preface; (2) Riverview; (3) A Healthy Waterway; (4) An Unhealthy Waterway; (5) Cleanup Technology; (6) Effects of Certain Other Pollutants; (7) Lake Tahoe; (8) The Role of the Individual; and (9) Schedule Sheet for the Unit. References to audiovisual materials, worksheets, and activities are made; these materials are not included with this publication but may be purchased. These materials have been validated as successful, cost-effective, and exportable by the standards and the guidelines of the U.S. Office of Education. (RH)

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PRIORITY ONE
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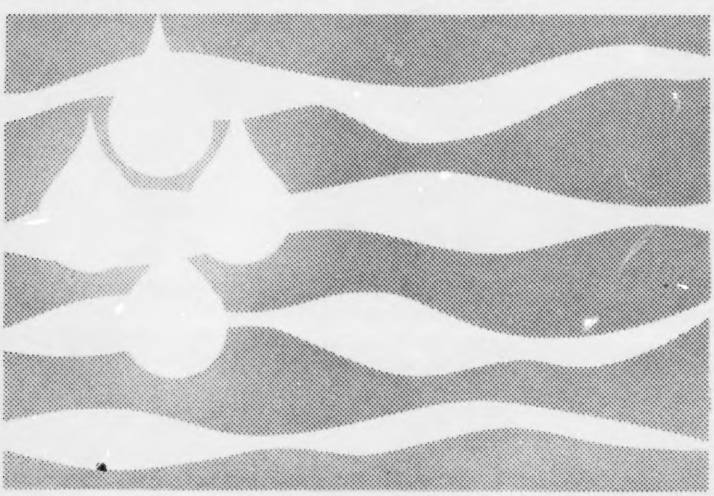

WATER SUPPLIES

PRIORITY ONE
environment

POLLUTION CONTROL EDUCATION CENTER
Township of Union Public Schools
Union, New Jersey

PROTECTING OUR WATER SUPPLIES

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PROTECTING OUR WATER SUPPLIES

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PREFACE

"Water, water everywhere, nor any drop to drink...." These words from Coleridge refer to sea water. But they could one day refer to all the water on our planet.

In our homes, day after day, we use and then discard hundreds of gallons of clean water. As a nation, we pride ourselves on our sanitary habits. We bathe regularly with various soaps and wash our clothing and kitchen utensils with detergents and phosphates. We even wash our cars and pets. But are we aware of what is happening to water sources and supplies as increasing millions of human beings continue to use and dirty them?

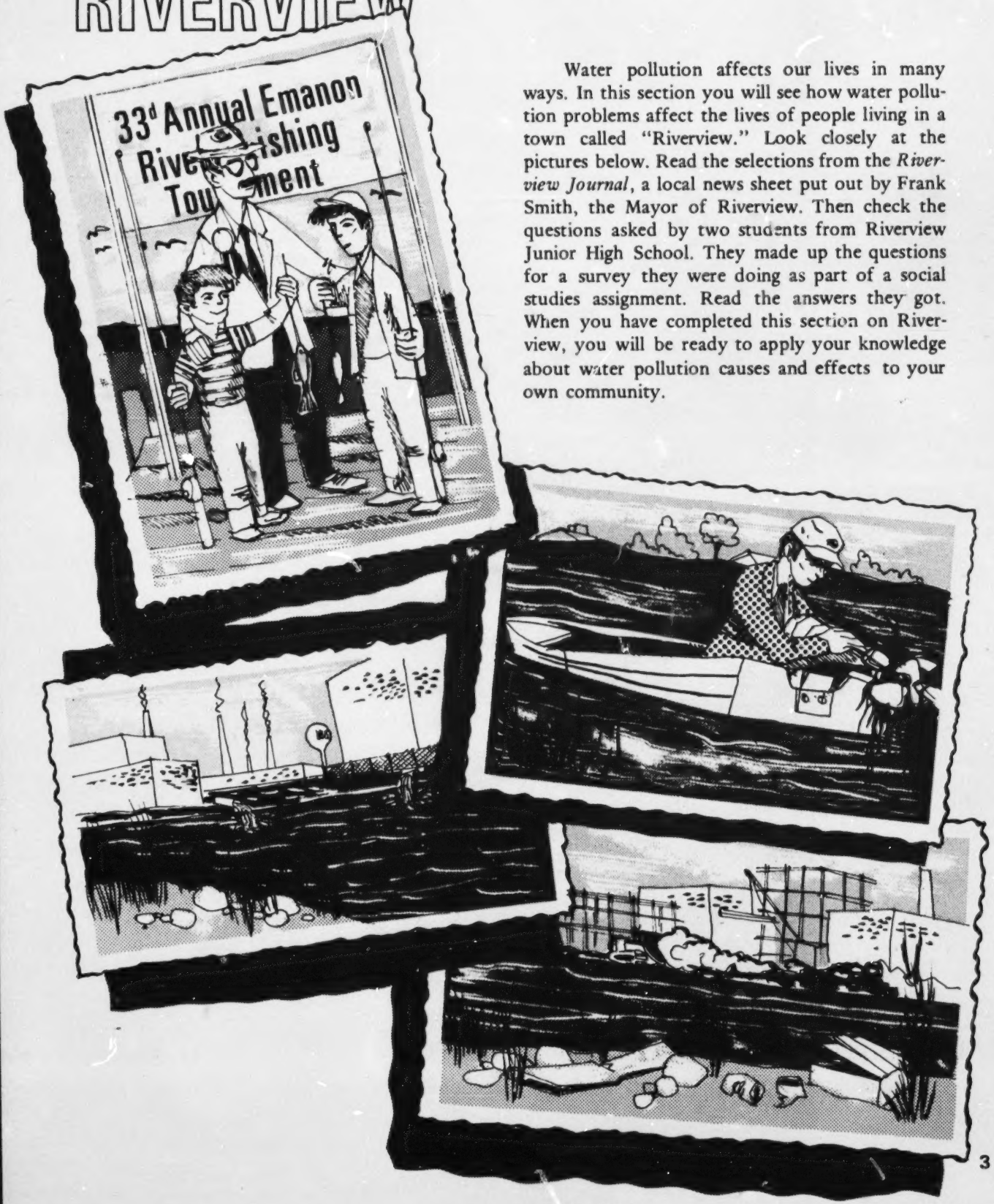
Many waterways are being turned into open sewers. At one time, due to the self-cleansing properties of water and the vast quantities of water in lakes and oceans, we thought we could depend on nature to dilute our wastes or carry them away. But natural cycles can no longer combat the pollution problems that are caused by the technology of a large human population.

On June 22, 1969, the Cuyahoga River in Ohio demonstrated to the people of Cleveland that it could no longer be depended upon to carry their wastes away. On a quiet Sunday afternoon, the Cuyahoga River burst into flames. Thousands of gallons of oil, which had been dumped into the river from a source never identified, suddenly caught fire and caused a great deal of damage. Fire is a visible and very dramatic way for a waterway to indicate years of neglect and abuse. There are other ways. In this unit you will learn to identify both the visible and the not visible causes of water pollution.

Almost no large waterway in America is free from pollution. Can we just allow the time to come when we may not have an adequate supply of clean water? All present and future taxpayers must become knowledgeable about **Protecting Our Water Supplies**.

In this unit, you will set up some experiments and determine for yourself what impact pollutants can have on a waterway. You will discover what technology can do to help *clean up* the water pollution that has already occurred, and what technology can do to help *prevent* further contamination of water sources and supplies. As you build up this information and knowledge, you will be encouraged to apply it to a study of your own area. Finally, you will have an opportunity to participate in the kind of decision-making process that regional and community planners everywhere must develop if they are truly concerned about **Protecting Our Water Supplies**.

RIVERVIEW



Water pollution affects our lives in many ways. In this section you will see how water pollution problems affect the lives of people living in a town called "Riverview." Look closely at the pictures below. Read the selections from the *Riverview Journal*, a local news sheet put out by Frank Smith, the Mayor of Riverview. Then check the questions asked by two students from Riverview Junior High School. They made up the questions for a survey they were doing as part of a social studies assignment. Read the answers they got. When you have completed this section on Riverview, you will be ready to apply your knowledge about water pollution causes and effects to your own community.

The Riverview Journal

State Health Inspector Sells Home

John D has sold his home and plans to move to the city. John has lived in Riverview for 23 years. When we asked John why he was leaving, he said, "For the third year in a row, members of my family have come down with eye infections. We think it's from the river. The infections disappear when we visit relatives in the city. So, we will move there permanently this spring."

Property Taxes to Remain Low

Thanks to your Mayor, Frank Smith, there will be no rise in property taxes for next year. For quite a number of years now, our tax increases have been small. This has been due to our tax income from the factory areas along the north bank of the river. Because the new industrial area along the south bank will mean new tax revenue for Riverview, the city council sees no reason for raising the present property tax. Progress is everything!

Fishing Tournament Won by High School Student

Sixteen year old Jimmy J won the 33rd Annual Emanon River Fishing Tournament. His prize catch was a 1 pound, 8 ounce catfish. Second prize went to Kathy C. She hauled in a 1 pound, 2 ounce carp. On the day of the Fishing Tournament, 47 anglers showed up. The tournament began at 6:00 a.m. and ended at 6:00 p.m. Sixteen fish were caught.

It is interesting to note that the all-time record for the Tournament, set back in 1952, was a 5 pound, 7 ounce rainbow trout. The record was tied the very next year with a 5 pound, 7 ounce large mouth bass. I guess they don't grow 'em that big anymore.

50 Years Ago, This Month

It was just 50 years ago this month that the Galena Mining Corporation shut down its operations upstream in Leadville. The Galena mine was founded in 1897 by Nicholas N who came to this country in 1888. "Big Nick" made his fortune in lead, the primary ore in this area. He also pioneered the development of the strip mining technique.

Big Nick found a cheaper way to mine the lead. He brought in huge steamshovels to strip thousands of tons of rock and low grade ore from the surface of the land to get at the richer lead ore underneath. He found that tunneling down to the richer ore cost more. Cave-ins in tunneled mines often stopped operations for days. The huge dump heaps of rock and low grade ore can still be seen along the north shore of Emanon River near the highway bridge just outside of town.

Local Student Wins Essay Contest

Pretty Miss Sandy R won an honorable mention in the state's essay contest for junior high school students. Sandy's winning essay was entitled "A Year in the Life of a River." In her essay, Sandy describes Emanon River in the spring, "high with runoff from the melting snows of winter." In the summer, she describes how the level drops and the water "warms up under the hot summer sun." Sandy links this fact with chemicals called phosphates to explain the tremendous growth of algae which occurs every August. Sandy also described how, in autumn, the "fall colors of the trees are reflected on the river for a double treat to the eye." And finally, winter, "when the river seems to stand still and rest as it freezes over after a year of untiring motion." Congratulations, Sandy! We're very proud of our young author.

Letter to the Editor

Dear Sir:

As a resident of Grand Falls, your neighboring community downstream, I thought your readers would be interested to know that **our** taxes for next year are going to skyrocket! We have just approved the construction of a water treatment plant to clean up our drinking water.

As you know, we have to get our water from the river, not from wells like you do. But because you people in Riverview are polluting Emanon River, WE must pay. I don't think it's fair. Every town should be responsible for its own waste water treatment and disposal and not leave it up to the towns downstream to clean up the mess.

Yours truly,

William C

cc: Editor, *Leadville News*
State Health Department

Name: _____ Age: _____

Occupation: _____ Rent: ___ Own: ___

1. How long have you lived in Riverview Township?

2. Why did you come here?

3. What do you like about the community?

4. What would you like to see changed in the communi

Name: *Mr. L* Age: *52*

Occupation: *Grocer/Post Master* Rent: Own: *X*

1. How long have you lived in Riverview Township?
I have lived in Riverview for 31 years.

2. Why did you come here? *I moved here after the war because the land was not very expensive.*

3. What do you like about the community? *City people in the summer makes running my store a very big success financially.*

4. What would you like to see changed in the community? *Not a thing. The factory people stop here on their way home and business couldn't be better. Some people are complaining about the pollution, but its not so bad as compared to the river as it nears the city. The Federal Government will do something about it I'm sure.*

Name: *Mr. & Mrs. P* Age: *48 & 47*

Occupation: *Executive—Int'l. Thumb-Tacks Inc.* Rent: *X* Own:

1. How long have you lived in Riverview Township?
First and last season.

2. Why did you come here? *I read an advertisement in the newspaper—that picture must have been taken in 1890, because the town and the river don't look anything like they're supposed to.*

3. What do you like about the community? *The TV reception is good.*

4. What would you like to see changed in the community?
Most everything. I came out here to get away from the smoke and noise of the city. I came out so I could relax and do things I can only dream about in the city. You know—fishing, boating, swimming. Well, the fishing is terrible. I lost the propeller to my boat when I hit a 50-gallon oil drum stuck in the mud just two feet down! Any my wife and I haven't stopped itching since we first went swimming almost two weeks ago! And the drinking water! Even though it comes from wells, it tastes terrible —as if it came right from the river.

Name: *Mr. J* Age: *31*

Occupation: *Forest Ranger, Emanon State Forest* Rent: Own: *X*

1. How long have you lived in Riverview Township?
10 years

2. Why did you come here? *I wanted to live near the State Forest.*

3. What do you like about the community? *It's close to work, beautiful colors in the fall, nice people, nice town.*

4. What would you like to see changed in the community?
I'd like to see a good sewage system put in, sometimes you can see the suds from people's washing. They ought to do something about the industrial growth around the river. And then there's that reactor. A friend of mine in the Department of the Interior has heard of a nuclear generator to be constructed upstream, north of Leadville. If I know our town council they would love to have it near here because it might bring tourists. Boy, that hot water would really ruin the river.

Name: *Mr. & Mrs. H* Age: *70 & 67*

Occupation: *Retired Gas Station Operator* Rent: Own: *X*

1. How long have you lived in Riverview Township? *We have lived here 38 years.*

2. Why did you come here? *We like the outdoors and many outdoor activities. We like the scenery, the fishing, the boating, and the swimming.*

3. What do you like about the community? *We like our river and the people who live near us.*

4. What would you like to see changed in the community? *We would like to see the destruction of the river stopped. Like that new complex on the south bank. All those factories do is belch smoke into the air and chemical junk into our river. Back in '52 I won the fishing tournament with a five pound trout. Why, we caught 106 fish that day —just 24 of us caught 106 fish! It's them stupid chemicals I tell you.*

Name: *Ms. S* Age: *14*

Occupation: *Student R.R.J.H.S.* Rent: *?* Own: *?*

1. How long have you lived in Riverview Township? *All my life.*

2. Why did you come here? *Family lived here.*

3. What do you like about the community? *Summer—we go to New England—town's dead—nothing to do—Used to be when I was a kid. Fishing's shot—water skiing too dangerous with the stuff floating out there. Water smells when it's hot.*

4. What would you like to see changed in the community? *More boys!!!!!!*

Name: *Mr. R* Age: *42*

Occupation: *Manager of Emanon Boat Rentals* Rent: Own: *X*
(1st hour $1.50—$.75 each additional hour, $2.00 deposit)

1. How long have you lived in Riverview Township? *I've lived here all my life.*

2. Why did you come here? *Got the house from my dad, the business too.*

3. What do you like about the community? *Well, the community is OK I guess. The people are nice.*

4. What would you like to see changed in the community? *I'd like to see them dredge up the west bend of the river. When they put in those factories, the runoff silted up the whole area. Why the water there must be only 2-feet deep! Because of this, the water reeds are choking it up so bad you can't put a rowboat or a motor boat through. And all the mayor is worried about is the taxes. Raise them—raise them I tell you and put in decent plumbing. Most of the homes here have septic tanks which seep into the river. I read someplace that this is why the algae really grows and suffocates the fish. There's no fun rowing a boat around if you can't fish for supper.*

A HEALTHY WATERWAY

Life in the Waterway

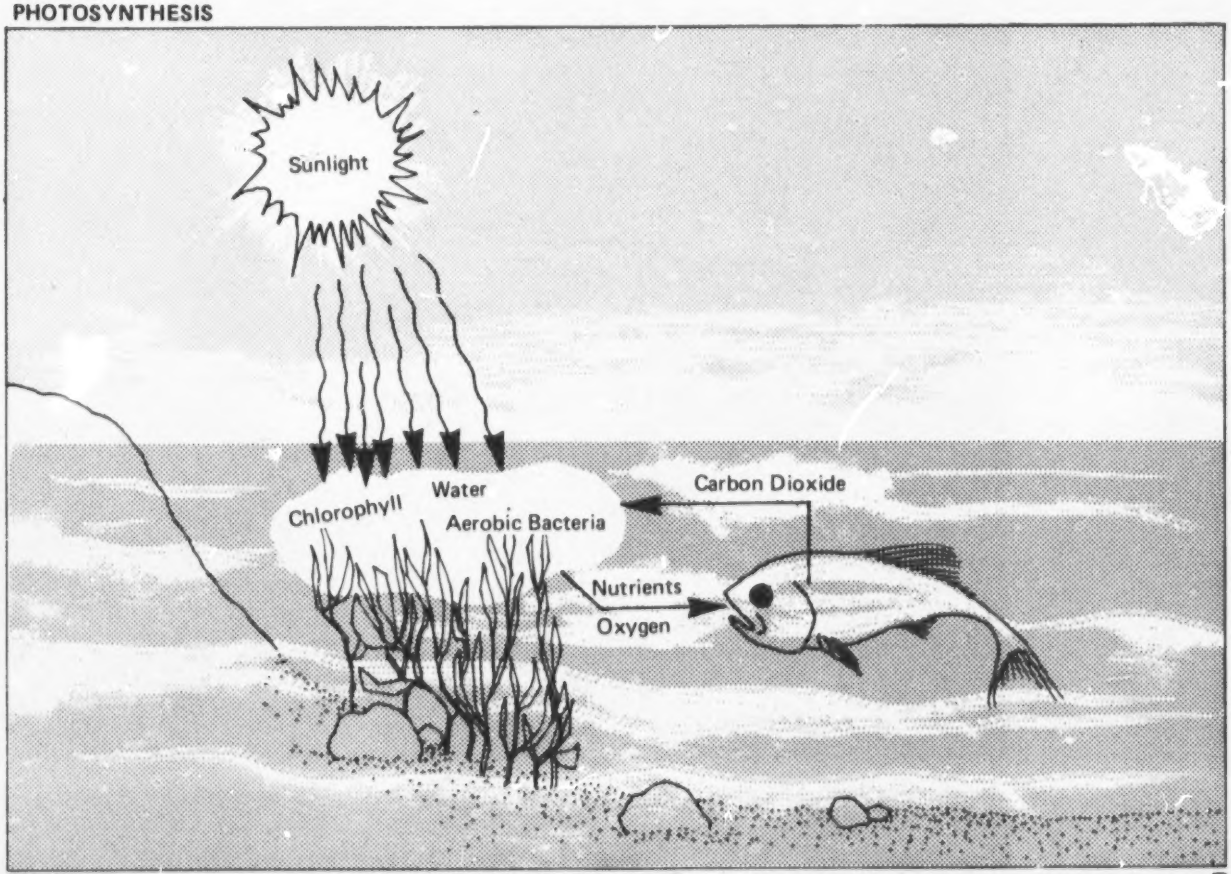
A healthy waterway, untouched by pollution, contains many forms of life. It is a home for fish, insects, amphibians, water birds, animals, and plants. In addition to those plants and animals that are easily seen, the water contains bacteria and other microscopic life. They need and depend on each other and their environment in this waterway community.

Many cycles are evident in nature. One is the *water cycle*. Water evaporates from large bodies of water into the air. The water vapor is stored in clouds before it condenses and falls to the earth in forms such as rain or snow. It then becomes part of the Earth's water supply for plants, animals, and humans to reuse.

Another is the *food cycle* or *food chain*. Microscopic plants and animals in the water are eaten by larger fish and animals. They, in turn, serve as food for still larger creatures. What is left of their uneaten bodies, and plant and animal waste material, is eaten by the microscopic forms of life commonly known as bacteria.

Photosynthesis is the process by which green plants use a pigment called chlorophyll, carbon dioxide, water, and sunlight in order to produce their own food and release oxygen. Water plants absorb some of the water around them and get carbon dioxide from the respiration of fish and other water animals. Aerobic bacteria (bacteria that use oxygen) transform plant and animal wastes into such nutrients as nitrogen and phos-

PHOTOSYNTHESIS



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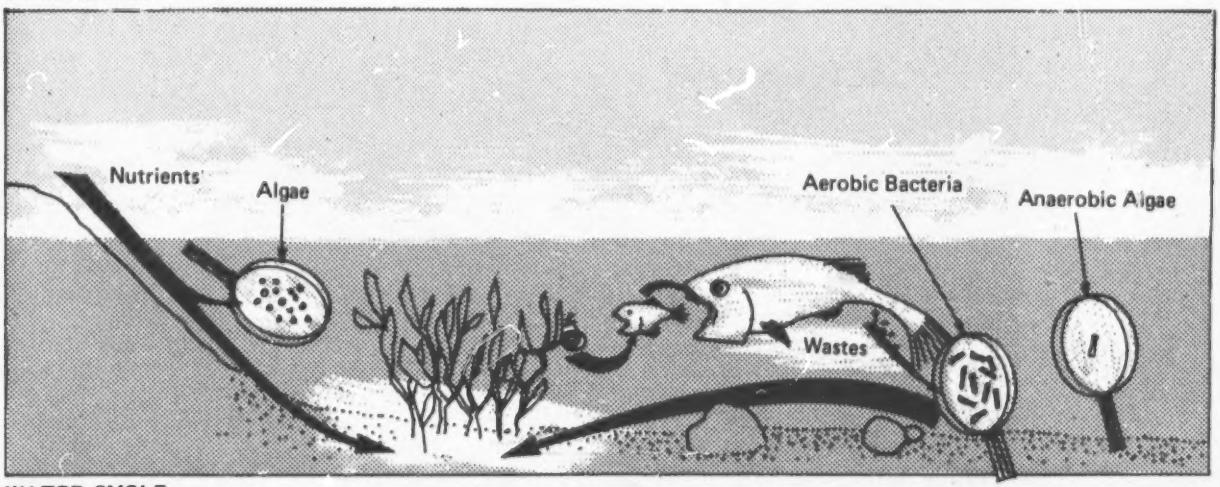
phorus, which are then recycled as food in the water community.

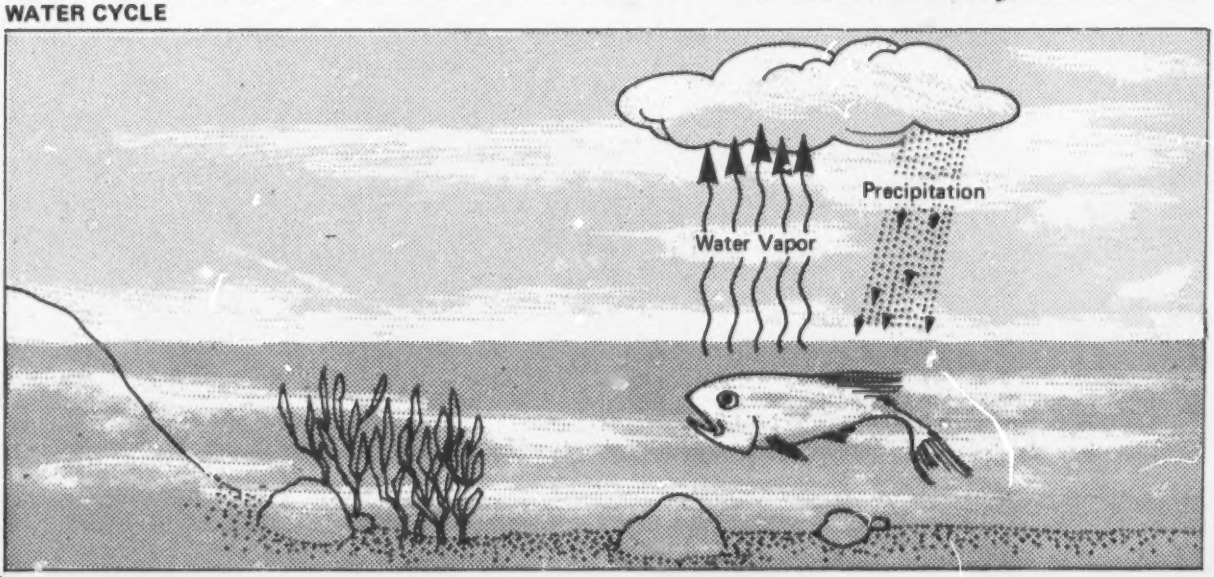
The interrelated cycles allow the waterway to purify itself. The biggest job in this self-purification process depends upon the tiniest of the organisms in the waterway community—the aerobic bacteria. They keep the cycle going by converting waste materials into new nutrients. But if there is much pollution, the bacteria will consume too much of the dissolved oxygen in the water and there will not be enough oxygen left to support the plant and animal life. The total demand for dissolved oxygen, by all the organisms present, is called the *biochemical oxygen demand*, or BOD.

When the balance of nature is undisturbed, and the natural cycles are uninterrupted, a waterway and the community which inhabits it are self-cleaning and self-sufficient.

FOOD CHAIN



WATER CYCLE



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AN UNHEALTHY WATERWAY

A foul odor, a sudsy foam, discoloration, dead fish and wildlife in and around a waterway are indications of water pollution. The pollutants described here are some of the many that endanger public health and pollute our water resources. Pollutants such as these interfere with the natural ability of the water to cleanse itself. Then it is time for man, who may be the cause of the problem, to enter the picture and do something to correct it.

1. **SEWAGE and other wastes from cities and industries, from marinas, pleasure craft and shipping** This sewage, both treated and untreated, contains organic wastes. The wastes are usually biodegradable. Aerobic bacteria in the water, if there is enough oxygen present, will chemically change these wastes. They will be changed into nutrients and minerals used by the green plants in photosynthesis, the food-making process. When too much waste is dumped into the water, the aerobic bacteria overpopulate. They then use up all the available oxygen and die. The lack of oxygen leads to a take-over action of anaerobic bacteria (bacteria that do not use oxygen). These bacteria do not need oxygen in order to destroy organic wastes. Anaerobic bacteria cause the water to become discolored and foul smelling.

2. **DISEASE–CAUSING BACTERIA, mainly from municipal sewage and feedlot drain-off** When sewage containing human and animal wastes enters the water we use for drinking, fishing, or swimming, it can contaminate the water with disease-causing bacteria. Coliform bacteria are normally present in the intestines of humans and animals. When they are found in a waterway they can be evidence that the water might also have harmful microbes in it. Some diseases spread in water are typhoid, cholera, and dysentery. Hepatitis, a virus which attacks the liver, can be traced to shellfish found in water polluted by human waste.

3. **NUTRIENTS, principally phosphates and nitrates from industrial wastes, land runoff, and sewage** The chemicals contained in this material act as nutrients. These nutrients increase the growth of water weeds and algae in the water. The process of *eutrophication*, or aging, takes place faster in a waterway polluted with phosphates and nitrates. Again, the anaerobic bacteria, which do not use oxygen, hasten the decay of plant life in the water and cause unsightly conditions and odors.

4. **SILTS, SANDS, AND DEBRIS, from streets, farm irrigation, industrial processing, road building, dredging, and construction** These sediments are carried by running water and are deposited into our waterways. The deposits fill in and accumulate wherever they are allowed to settle. They block out the sun's rays necessary for the growth of oxygen-producing plants that live in the water. These sediments also disturb the food-making process which depends on sunlight—photosynthesis.

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CLEANUP TECHNOLOGY

For many millions of years nature has been recycling the water on our planet. Clean water falls to the earth as rain or snow. Some of it soaks into the ground and is used by plants. Some water runs off the land, gathers in streams and rivers, and collects in lakes or in the oceans. Throughout this flow, water becomes dirtier. It picks up silt and minerals from the soil and waste materials from animals and from decaying plants. But nature reclaims this water from streams, lakes, and oceans by the process of evaporation. Water vapor produced in this evaporation rises into the atmosphere, forms clouds, and returns to the earth as rain or snow. This constant movement of water is called the *water cycle*.

For hundreds of thousands of years man used and dirtied water within this cycle. His wastes frequently entered waterways. The flowing water cleaned itself as sunlight, oxygen, and helpful bacteria destroyed the harmful materials in the water. And man continued to have a ready supply of fresh water.

During this century, however, there has been a tremendous increase in the amount of human and industrial wastes entering the water cycle. Technology has changed the way in which we get rid of our wastes. In the past, much human waste was disposed of in the ground under "outhouses," or in cesspools or septic tanks. But today almost all towns and cities have sewer systems. Contrary to what many people think, not all sewage water is cleaned before it enters the water cycle again. There are hundreds of cities with sewers which empty the untreated wastes directly into the nearest waterway.

Sewer systems do two jobs. They carry away wastewater, and they drain off the water from rain or snow. Some towns have one sewer system that does both jobs. Other towns separate the sewer system into storm sewers for draining runoff from rain or snowfall and sanitary sewers, which carry wastewater from homes, businesses, and factories. Most industries either dispose of their liquid wastes into the municipal sewer system or discharge them into a waterway.

Of the cities which have sewage treatment plants, about 30% have a form of treatment consisting of screens and settling tanks which remove only about one third of the organic solid waste from the sewage water. About half of the cities which treat their waste water add a second step of treatment to screening and settling tanks. They use bacterial action to reduce organic matter. This more efficient process can remove between sixty to ninety percent of the organic waste from sewage water. Only a very few localities use more effective treatment processes on their sewage wastes. If we average the effectiveness of the nation's sewage treatment, we would see that only about one-half of the organic wastes are removed from our sewage. The other half pollutes the nation's water.

Sewage Treatment

The most commonly used sewage treatment is the process called ***Primary Treatment***. In this process the sewage flows through screens which remove larger solid objects. The sewage then passes into a channel or tank where silt, sand, or grit settle out. The sewage water is then held in sedimentation tanks where suspended solids can collect as sludge on the tank floor. Finally, the waste water is often treated with chlorine to kill disease-causing bacteria and is then discharged into a waterway.

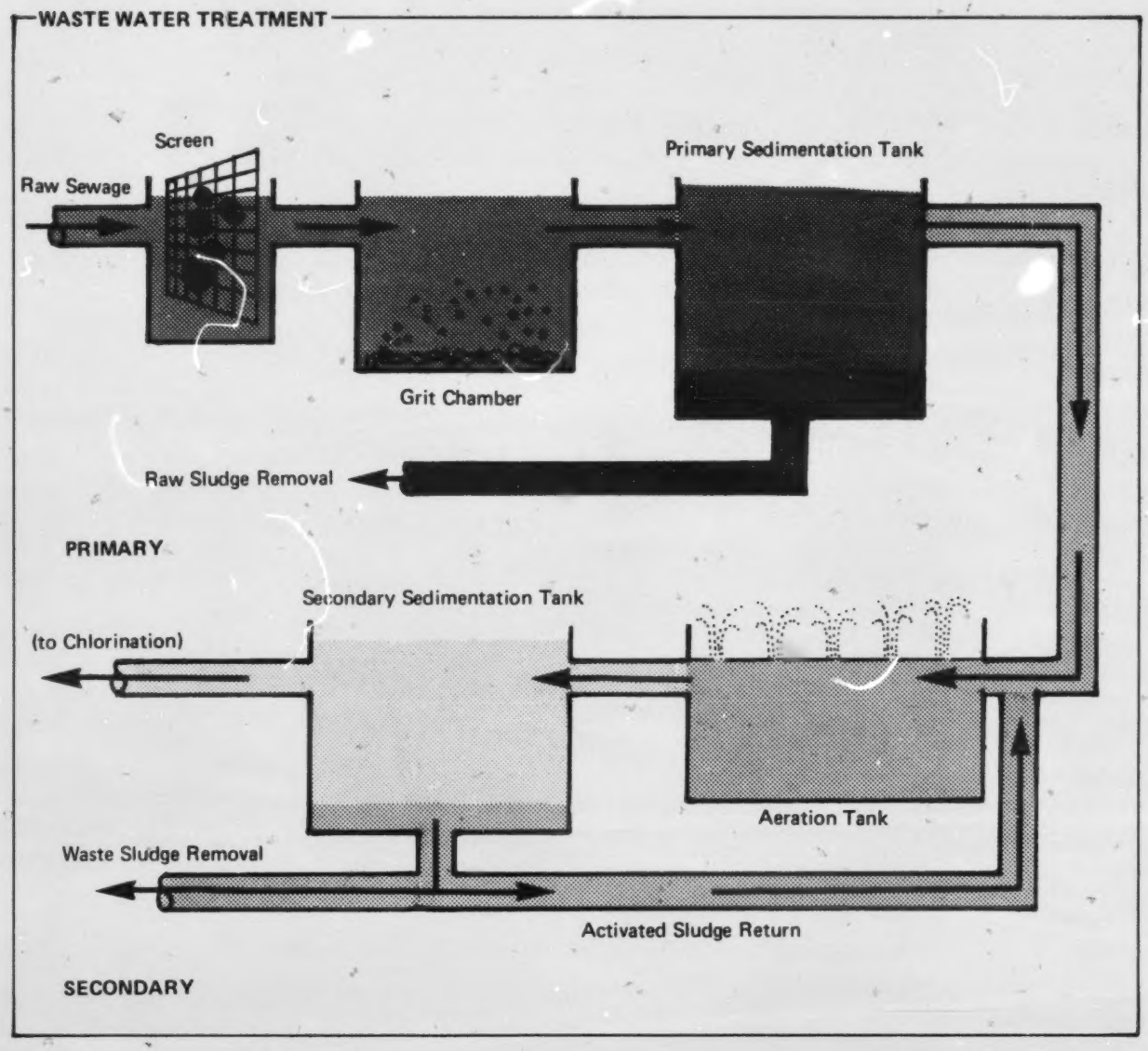
If sewage wastes are further processed, the added steps are referred to as ***Secondary Treatment***. The most common types of secondary treatment use either a trickling filter or the activated sludge process. These are biological cleaning methods which use bacteria to rapidly decompose organic wastes.

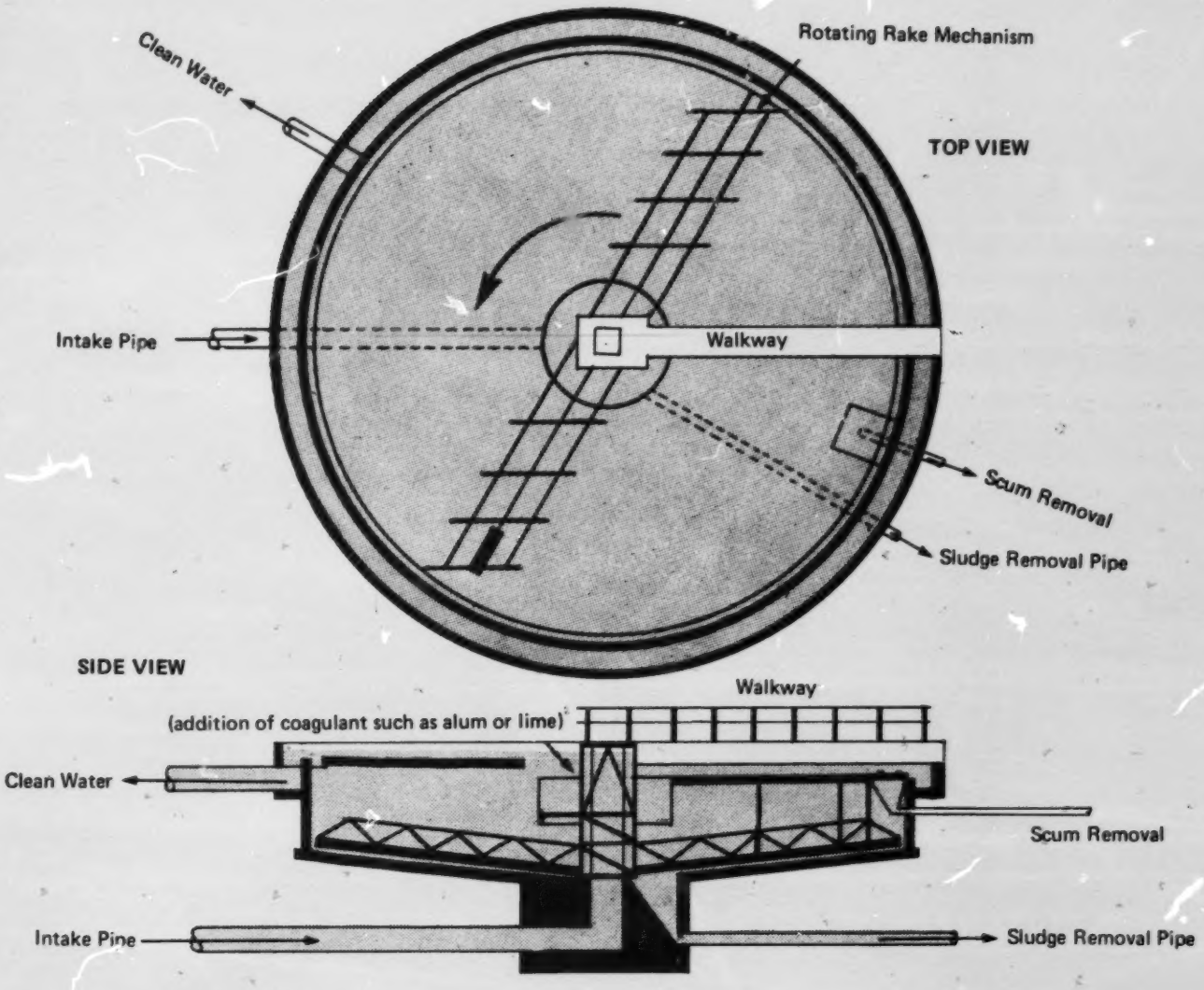
A trickling filter receives sewage after it has had primary treatment, but before the sewage has been chlorinated. Usually the sewage is sprayed

over a bed of stones and trickles through. The stones are covered with bacteria which consume most of the organic matter in the sewage. The cleaner water coming from the filter is then chlorinated and discharged.

In the activated sludge process primary treated sewage is mixed with air and bacteria-rich sludge. The oxygen in the air activates the bacteria to consume the organic matter in the sewage. In this process, too, the sewage is then chlorinated and discharged.

Both the trickling filter method and the activated sludge process can achieve up to a ninety percent reduction of organic wastes in sewage when the operation is running perfectly. However, this efficiency is very difficult to maintain. Too frequently, the capacity of the treatment plant cannot handle a large flow of sewage, and raw sewage is directly discharged. If industries use the sewer system, their chemical wastes may not be cleaned from the water in primary or secondary treatment and these wastes can kill off the helpful bacteria in the filter or digestor and the organic wastes in the sewage are then not consumed.



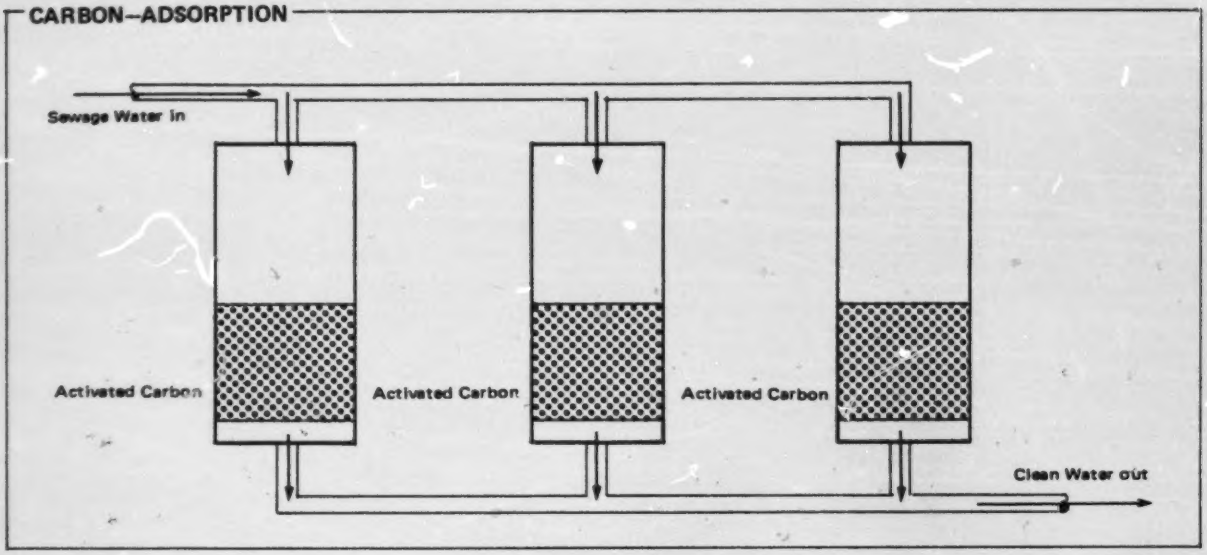


A COAGULATION–SEDIMENTATION TANK

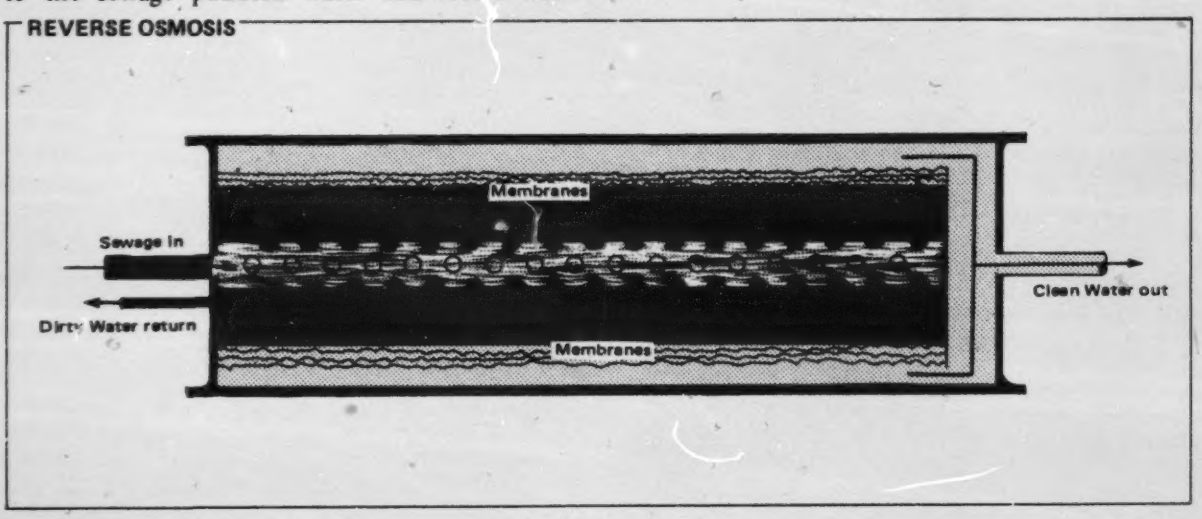
One way of cleaning sewage wastes more effectively has been to add further water treatment after primary and secondary treatment. These added steps are often called ***Tertiary Treatment***. Tertiary treatment includes a number of techniques that do not rely on biological processes. Tertiary treatment at times involves only adding a sand filter to the secondary treatment. At times the filtration process uses a rotating screen with microscopic holes that strain out the small particles of unwanted materials left in the water after secondary treatment.

More frequently tertiary treatment adds a coagulation-sedimentation step to secondary treatment. As the sewage comes from secondary treatment it is held in large tanks. Alum or lime is added to the sewage water. These chemicals cause the fine impurities remaining in the water to coagulate or "floc" and form larger particles. These particles settle out of the water and collect as sediment at the bottom of the tank. The clean water is then piped out.

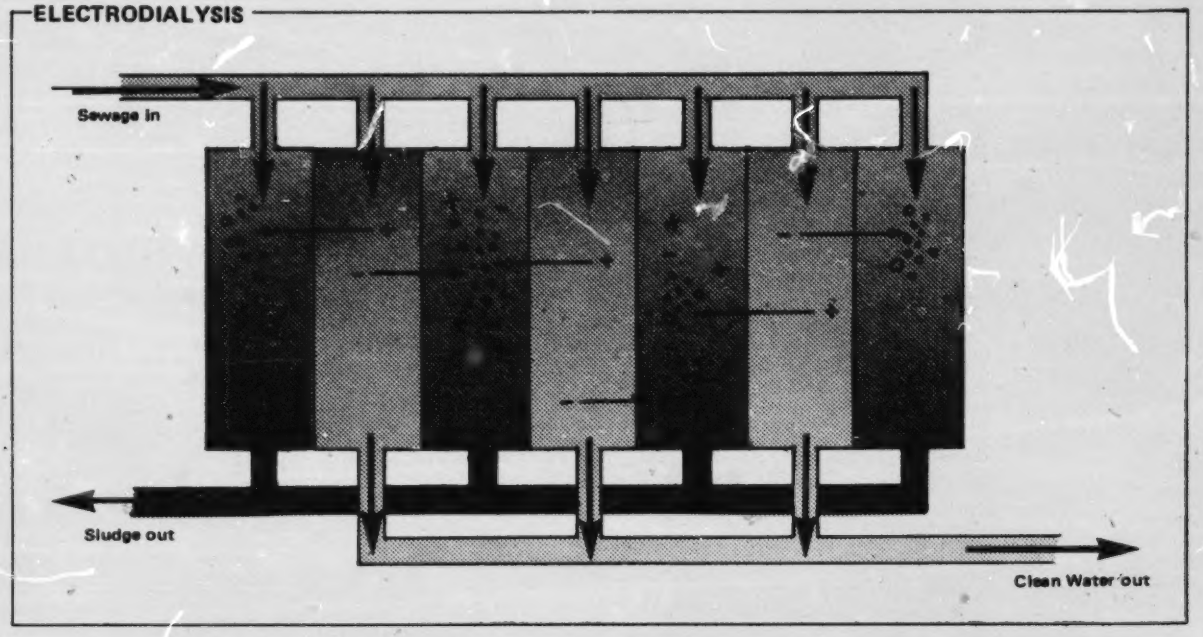
Carbon-adsorption A tertiary method becoming more popular is *Carbon-adsorption*. In this treatment the sewage is passed through a bed of activated charcoal. Adding the activated charcoal step to the treatment process can remove up to ninety-eight percent of the organic matter. Further, organic matter that resists biological treatment is removed by carbon-adsorption.



Reverse Osmosis A treatment process which is being used experimentally is one called *Reverse Osmosis*. Osmosis occurs where two solutions are separated by a membrane through which molecules of the solution can pass. Normally molecules of water will flow from the solution with a higher concentration of water to the solution with a lower concentration of water. For sewage treatment, the process can be reversed. A pump applies pressure to the sewage polluted water and forces water molecules through a membrane to the clean water side. In this process clean water is taken out of sewage rather than sewage taken out of water. The theory of reverse osmosis has been used in laboratories, experiments, and in industry for some time. But the process is not widely used in sewage treatment. One of the problems that must be solved is how to prevent the filtering membranes from rapidly clogging up.

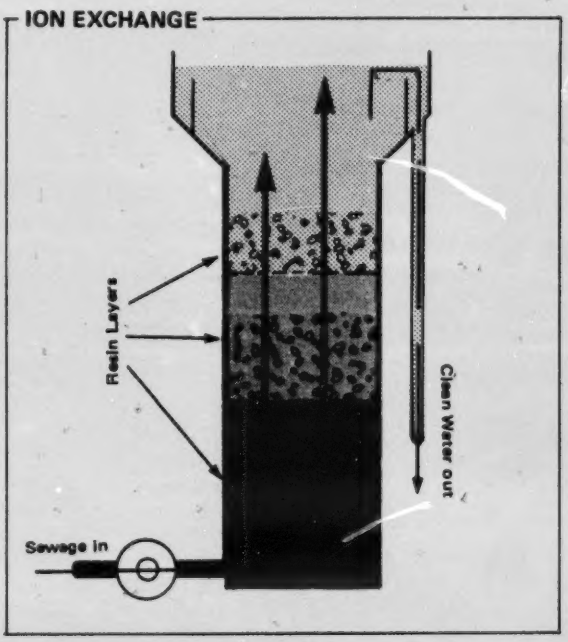


Electrodialysis Another experimental water treatment procedure which uses membranes as filters is *Electrodialysis*. Many pollutants exist in water in the form of salts. In the electrodialysis procedure the salts in the sewage water are ionized (separated into positively and negatively charged particles). The positive ions in the sewage are filtered through one membrane toward a negative electrode. The negative ions in the sewage are filtered through another membrane toward a positive electrode. The membranes and electrodes can be arranged in patterns so that most of the pollutants in the water are filtered out.



Ion Exchange A chemical process called *Ion Exchange* has been used commercially in water treatment for many years. Experiments are being conducted to adapt this process to sewage treatment. In this process certain resins are chosen which will attract ions of pollutants in sewage. As the sewage flows past this resin, the polluting ions in the sewage water are attracted to the resin in exchange for ions in the resin. Specific resins can be selected to remove specific pollutants.

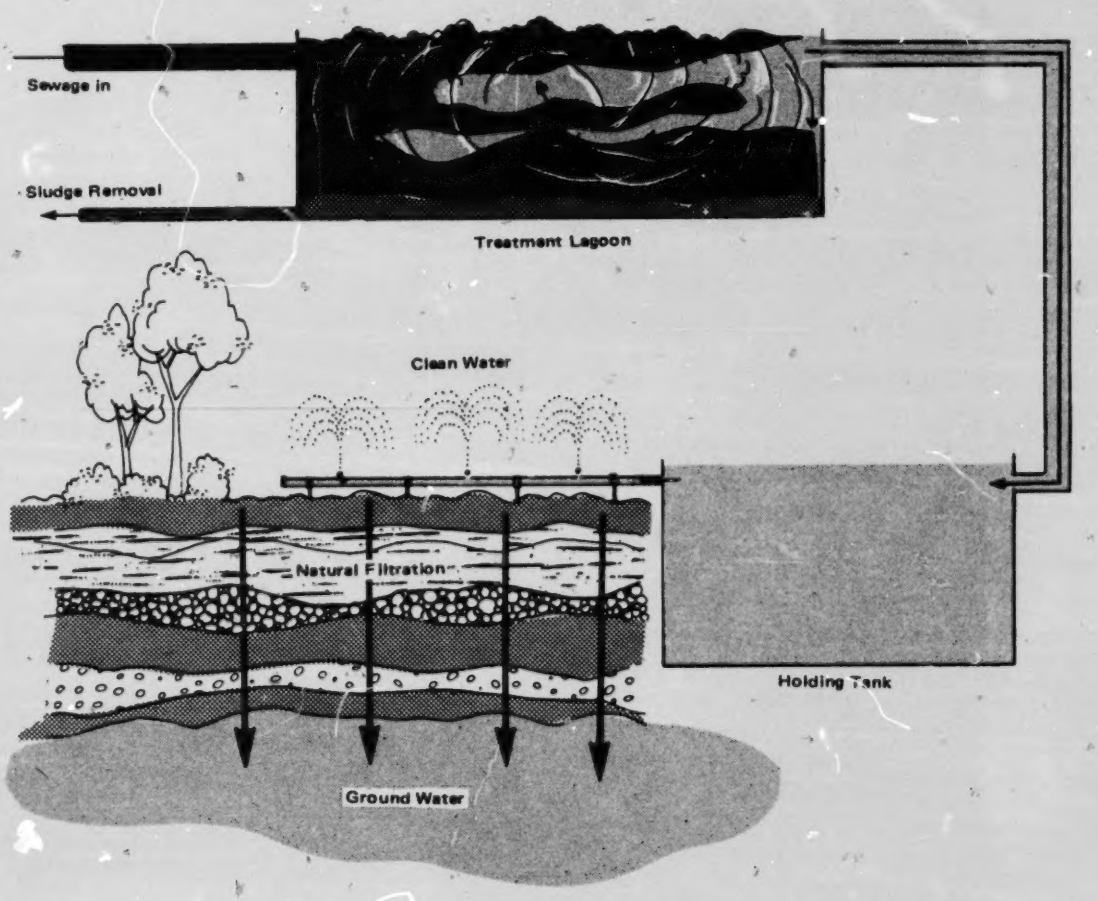
Some cities are using these newer methods of treatment not just as the tertiary stage of sewage treatment, but as the main treatment process after screening and grit removal. These cities are trying to use the more sophisticated water treatment methods in their new sewage plants to avoid what might be the unnecessary expense of constructing traditional secondary treatment facilities.



The Living Filter A method of water treatment that closely follows natural processes is to hold the sewage in large outdoor lagoons to allow sunlight and bacteria to consume the organic wastes in the water. Modern lagoon methods are using increased flow of oxygen and rich bacteria sludge to remove the organics more effectively. The water is then sprayed on the land. Biological, chemical, and physical reactions in the soil purify the water. This method of sewage treatment can be very effective for smaller communities where sufficient land is available for the process.

As our population grows, it becomes more necessary for effective sewage cleanup to be applied to our increasing sewage wastes. Industry too must remove polluting chemicals from waste water before that water gets back into the water cycle. Good technology wisely used can help us preserve the supply of clean water needed by man and by all other living things on Earth.

THE LIVING FILTER



EFFECTS OF CERTAIN OTHER POLLUTANTS

The biggest sources of controllable man-made water pollution are industrial pollution, sewage or domestic wastes, agricultural and livestock runoff, and oil spills from shipping. The earlier sections of this booklet have presented the problems caused by domestic wastes and suggested the proper use of technology to solve these problems. In this article you will see how these other sources of pollution affect our water supplies.

INDUSTRIAL POLLUTION

Industry is by far the leading discharger of liquid wastes in the United States. The volume of wastes from industry is about five times greater than that from domestic sewage. Moreover, industrial wastes are generally more harmful, composed of more kinds of pollutants, and more difficult to treat than is sewage.

Industrial wastes include many toxic substances that either poison living things, or affect their environment in ways which cause them to die. Some examples are cyanides found in metal plating and steel mill wastes or sulfides found in the wastes from oil refineries, metal smelting operations, and chemical plants. Lead, mercury, and cadmium are three of many metals which industry discharges into the water environment.

Lead Although the dangers of lead poisoning have been well known for many years, lead is still one of the most common industrial wastes. In humans, lead poisoning affects the central nervous system, kidney performance, and the production of blood. Young people, especially children, are most susceptible to lead poisoning. The impact of lead contamination on the food chain is not known as yet.

Mercury The way in which mercury poisoning grows through the food chain is well known. When mercury and some mercury compounds first enter the water, they are relatively harmless. However, the action of microbes in water convert these safer forms of mercury into the highly toxic compound, methyl mercury. This compound is absorbed by microscopic plant life. The plant life is consumed by the smaller water creatures, and the methyl mercury is concentrated in their bodies. Small fish eat the water creatures and in turn are eaten by larger fish. At each stage in this food chain more mercury concentrates in the cells of the consuming fish. In some cases the concentration of mercury has been found to be five thousand times greater in the fish than in the surrounding water.

Between 1956 and 1973, three outbreaks of severe mercury poisoning occurred in Japan. These outbreaks were directly traced to methyl mercury in fish, which was a major item in the diet of the Japanese who became ill. Scores of people died and thousands suffered loss of vision, muscle impairment, or mental deterioration.

Cadmium Contaminated drinking water can be a source of cadmium poisoning. The symptoms of this poisoning have been named the Itai-Itai (Ouch-Ouch) disease because they result from a very painful deterioration of the bone structure. In a 1970 survey of surface water at hundreds of locations throughout the United States, four percent of the samples were over the acceptable limits for cadmium. In another survey, water samples taken directly from drinking water taps showed excessive amounts of arsenic, iron, manganese, cadmium, and lead.

Polychlorinated Biphenyls Among the most widespread pollutants in the world are the PCB's, or polychlorinated biphenyls, which have spread in this century from pole to pole. It has been estimated that the Great Lakes alone now contain over one-hundred tons of PCB's. They are persistent in the environment. They do not dissolve in water, but are soluble in animal fat. They have been found in plankton throughout the oceans of the world, in the flesh of fish, seals, whales, penguins, and in many species of birds.

PCB's are a serious concern because, like DDT, they have been linked with disruptions of the reproductive cycle in many species. In man they have caused eye damage, serious skin conditions, and even death from atrophy of the liver.

Thermal Pollution Heated water added to a waterway in such quantity that it harms the water community is called thermal pollution. Most often it is caused by the industrial discharge of large quantities of heated water that was used for cooling purposes. Water is also used extensively as a coolant in electric generating plants.

Thermal pollution can reduce the dissolved oxygen content of the water and cause extensive fish kills.

AGRICULTURAL AND LIVESTOCK RUNOFF

Agricultural chemicals can get into water supplies from farm runoff. These chemicals include nitrate fertilizers; organic compounds from animal wastes; herbicides such as 2,4-D and 2,4,5-T; and pesticides such as chlordane, DDT, aldrin, and deildrin. Nitrate levels in water sources have risen along with the rapid increase in the use of nitrate-based fertilizer. When nitrates in food or water supplies enter the human body, they can be converted to nitrites, which cause red blood cells to lose their ability to carry oxygen. Infants are most susceptible to this condition—often called "blue babies." Other symptoms of nitrite poisoning include behavioral disturbances and mental deficiency.

Modern livestock feeding methods have increased water pollution from animal wastes. In the past livestock grazed in open fields and ranges and their droppings were recycled through the soil with little direct runoff to nearby waterways. Today, most of the cattle fed in the midwestern and western states are fed in feedlots ranging from 1,000 head to 20,000 head. The runoff from the animal droppings in lots of such size often results in high concentrations of pollutants reaching nearby streams.

The chlorinated hydrocarbon pesticides and herbicides such as DDT and 2,4-D have entered waters throughout the world. They have been important factors in increasing the world's food production, but they—as well as the PCB's—are suspected to have harmful effects on the health and reproductive capacity of animals and man. For example, significant amounts of DDT have been found in many species of birds known to be threatened with extinction, such as eagles, falcons, ospreys, and pelicans.

OIL POLLUTION

The oceans of the world are the final receivers of an enormous amount of pollution. Rivers empty hundreds of tons of waste chemicals into the sea, and a wide variety of effluents come from coastal towns and cities. But oil remains the single biggest pollutant. Estimates are that between 5 and 10 million tons of petroleum products are going into the oceans every year. Most of this oil is dumped in coastal waters, where the life of the sea is richest.

This oil pollution is spread over all the oceans of the world. Sir Francis Chichester, a yachtsman who sailed around the world in a small boat, reported that he frequently sailed through oil slicks and that waves coming aboard his yacht left clots of black oil on the deck and stained the sails. In 1969 Thor Heyerdahl sailed his raft *Ra* from North Africa to the Caribbean. He discovered that "at least a continuous stretch of 1,400 miles of the open Atlantic is polluted by floating lumps of solidified, asphaltlike oil." An American survey of the surface pollution of the sea estimated that more than 80,000 tons of tarry residues are floating on the oceans. From the Arctic to the Antarctic about ten percent of the surface of the sea is covered with visible oil pollution. We must also learn more about the dissolved hydrocarbons, which are among the most toxic oil components. What effect these dissolvable fractions of oil have is not yet known.

Ships discharge oil into the sea in many ways. The most spectacular damage is done when large oil tanker ships are damaged by storms or run aground and spill their cargo. When the tanker *Torrey Canyon* went aground on the British coast, it spilled over 100,000 tons of oil into the sea. Supertankers carrying more than 200,000 tons of oil are becoming more common.

Extensive as is the damage from accidental oil spills, it is deliberate oil dumping that accounts for most of the oil in the oceans. Accidents spill about 350,000 tons of oil a year, but official estimates are that about 1,400,000 tons of oil are discharged into the sea every year in the routine operations of tankers and other ships. This comes mainly from the oil sludge dumped when the ships fill their fuel tanks and cargo tanks with water—either as ballast or to clean the tanks—and then dump the contents into the sea.

LAKE TAHOE

Lake Tahoe is one of the world's deepest, clearest, and most beautiful fresh water lakes. It is located high in the Sierra Nevada Mountains on the California-Nevada border. The Lake Tahoe Basin, located near the Truckee River, includes an area 40 miles long and 18 miles wide—with a total surface area of 327,878 acres.

More than 11,000,000 tourists enjoy the year-round recreation facilities of the Tahoe area. In winter, skiing and mountain climbing are popular. Camping, hiking, fishing, and water sports attract people in the summer. Gambling, which is legal in Nevada, also brings many people to the area. The permanent residents now number about 30,000. This number shows a considerable increase since 1940, when fewer than 10,000 people lived in the Tahoe Basin. With increasing numbers of new roads, home sites, and recreation areas, Lake Tahoe faced a real growth problem—water pollution.

In 1963, engineers studied the lake's sewage disposal. They knew that the lake's great size and depth enabled it to handle naturally some purification of sewage. However, when objectionable amounts of green algae began to appear at sewage outlets in the lake, it became clear that something had to be done. Concerned citizens and governmental agencies went into action. The Department of the Interior, together with other federal agencies, held a conference in 1966. Two outcomes of this meeting were that all sewage would be exported out of the Lake Tahoe Basin and that a new advanced sewage treatment plant would be built.

After government and state aid, the new 28 million dollar South Tahoe Public Utility District's tertiary water treatment plant began to operate in 1968. Tertiary treatment involves extra filtering and the addition of chemicals after the primary and secondary steps of regular sewage treatment. Most of the phosphates and nitrates, and all of the sludge, bacteria, and harmful chemicals are removed by the tertiary process. The effluent can be made clean enough to drink. In Tahoe, the effluent is pumped into a man-made lake, Indian Creek Reservoir. The stored water at Indian Creek is used for irrigation. It also has been stocked with rainbow trout and has become a spot for water sports.

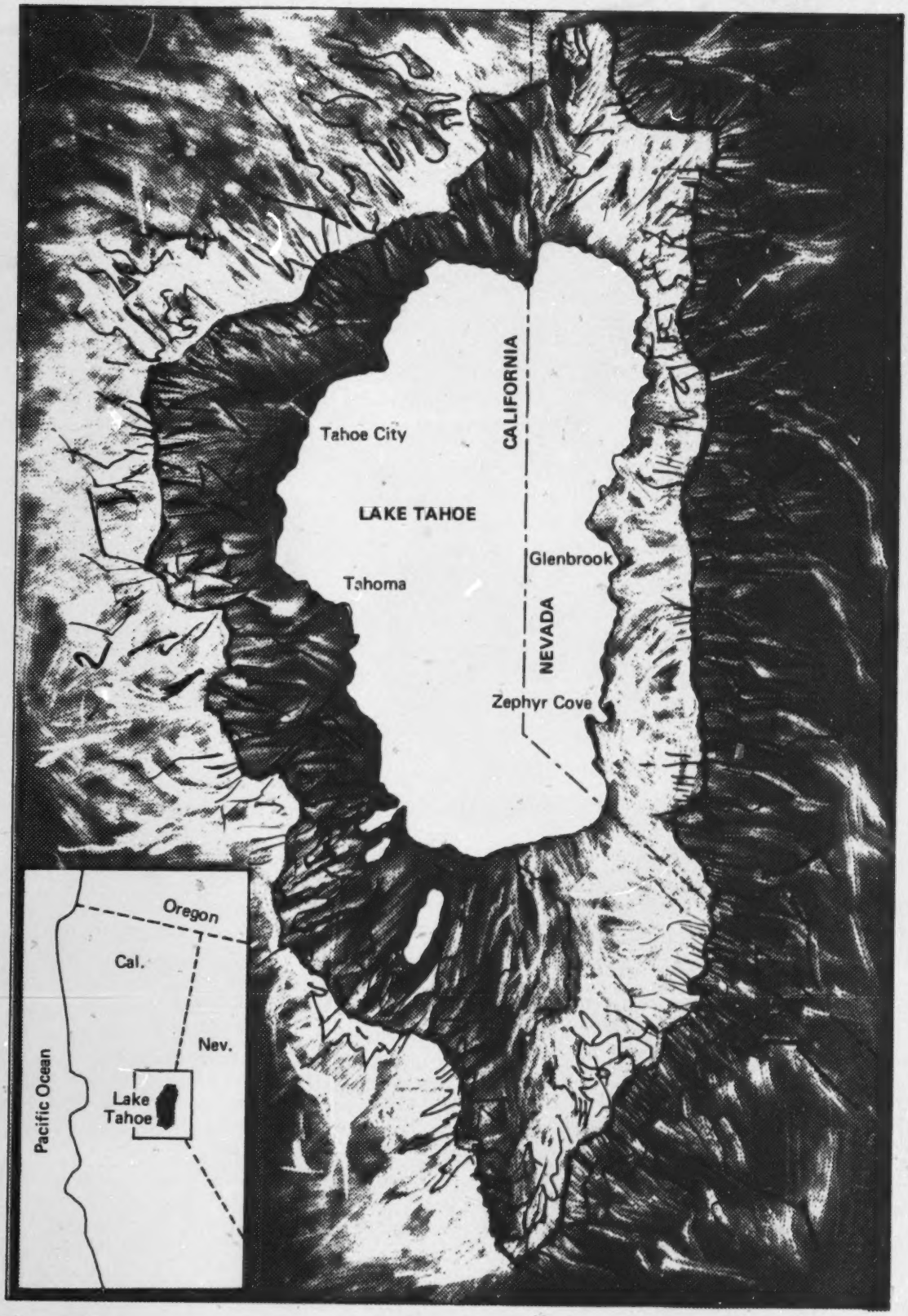
Residents get their household water from the Truckee River watershed and not directly from Lake Tahoe or Indian Creek Reservoir. The Truckee River is also used to supply water for irrigation.

The North Tahoe and the Tahoe City Public Utility Districts at one time disposed of their sewage at the Cinder Cone disposal site in the Tahoe National Forest. Then another tertiary sewage treatment plant was completed to service the northern Tahoe Basin. A few areas in the outskirts of the Tahoe Basin, both in California and in Nevada, continued to use (and still do) the septic tank method of waste containment.

However, when the sewage problem seemed to be solved, another problem arose. Lake Tahoe's waters are very sensitive to sediments and silts washed into the lake by streams and the runoff from rainfall upon the extensive watershed. These sediments contain nutrients which stimulate the growth of algae. The silts also prevent sunlight from reaching the lower depths of the lake. The two conditions accelerate the natural aging process of waterways known as *eutrophication*.

This problem could be solved only by control of erosion, which was being caused by building developments, lumbering and mining operations, and animal over-grazing. The people of the area became concerned about the impact of sediments and silts on the quality of Lake Tahoe's water. They sought aid from the federal and the bi-state governments. Land developers, civic leaders, and environmentalists joined together in a regional approach to combat the growing eutrophication problem.

The establishment of the Tahoe Regional Planning Agency (TRPA) in 1969 had as its purpose the prevention of damage to the Lake Tahoe Basin caused by uncontrolled land development. But the TRPA was not strong enough at first to control local business interests, which had invested millions in resort facilities and in a land development building boom.


Tahoe City
CALIFORNIA
LAKE TAHOE
Glenbrook
Tahoma
NEVADA
Zephyr Cove
Oregon
Cal.
Nev.
Pacific Ocean
Lake
Tahoe

20

But in 1971, the TRPA's General Plan was adopted. The main portion of the plan was an outline of strategies for acceptable land use. The plan divided the Basin into land-use districts, one of which is the general forest public land. At first, it was estimated that the greatest human population for the whole Basin could be about 280,000. This figure included both the permanent and the seasonal population, but not visitors to the public lands. Later it was realized that a Basin population could include as many as 450,000 people, according to the provisions of the General Plan.

Therefore, a new Master Plan was prepared by the Tahoe Regional Planning Agency. The Master Plan limits growth to the areas which are already developed, and allows only another 4% of available land in the Tahoe Basin to be developed. The plan closes 34,000 acres to future building. In addition, builders must observe a one-story height limit on their buildings. They must also submit reports to the TRPA on the effects of their constructions on Tahoe's environment. The Master Plan controls commercial timber-cutting, mining, and livestock grazing in the National Forest in the Basin. The TRPA is also responsible for evaluating and updating all policies on recreation facilities, conservation, transportation, outdoor advertising, and air and water pollution.

The success of the Master Plan depends upon the cooperation of the states (California and Nevada), the counties, and the cities in the entire Tahoe Basin area. For the plan to be effective, everybody must cooperate in its enforcement.

Many experts regard the Tahoe experiment in regional control as a successful model for other regions to follow. Would you agree?

Can You Answer These?

1. Is the recycled water from the two tertiary treatment plants discharged into Lake Tahoe?
2. What pollution problems can be caused by run-off containing sediments and silt?
3. What was the original purpose behind the TRPA?
4. What does tertiary sewage treatment add to primary and secondary treatment?

THE ROLE OF THE INDIVIDUAL

As concerned citizens become aware that problems exist in the area of water pollution, questions like these are often asked: What can I do to correct what is wrong? Has the government provided laws to eliminate these problems? How can I get my friends and neighbors interested in doing their part?

When an individual sees that he too is a cause of water pollution and that he can work for its prevention, he takes a step in a forward direction. Besides following the list of *Do's and Don't's* for individuals which you will find at the end of your booklet, other methods are available for each person to become actively involved.

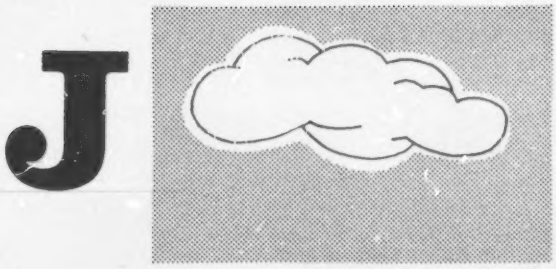
Groups and organizations are already working for clean water. Educational, technical, and scientific organizations as well as civic and religious groups are looking for helping hands to distribute information materials to the general public. The *Conservation Directory*, published annually by the National Wildlife Federation, provides a comprehensive list of groups that you can contact and help support.

But citizen involvement without the support of all levels of government would be ineffective. Fortunately, government at all levels—federal, state, and local—is not only aware of water pollution problems, but professes a desire to combat them. As early as 1965, the Water Quality Act, involving both federal and state programs, was enacted. Realizing later that this legislation was not strict enough, government officials took steps to enact, after three years of study, the comprehensive Federal Water Pollution Control Act (FWPCA) Amendment of 1972. This legislation, regulated through the Environmental Protection Agency (EPA), extends and strengthens federal and state regulations of all navigable waters. It prohibits toxic discharges, strengthens and streamlines federal enforcement procedures, and permits citizens to bring legal action to enforce FWPCA requirements. These are just a few of the provisions of FWPCA. This Act, which became law in 1972, is not limited to the problems that could be solved by legislation in 1972. It projects regulations and requirements to be met from 1972 to 1985. The aim of the Federal Water Pollution Control Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Act establishes that pollutant discharges are to be eliminated on a nationwide scale by 1985.

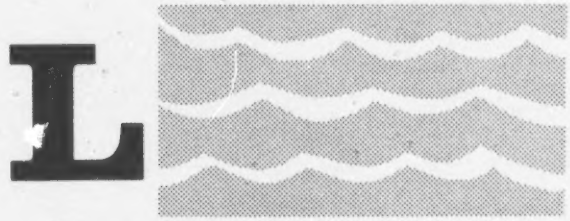
Two programs have been put into operation to achieve these goals. One is a system by which the federal government provides grants to plan and construct municipal waste treatment plants. Second is the establishment of the permit program. Any factory, municipality, or large agricultural operation that discharges wastes into the nation's waters such as by sewer, ditch, tunnel or conduit, must have a permit to do so. These sewers and such are called *point sources* when they release directly into a waterway. Permits regulate discharges from all point sources and establish effluent limitations. By the permit system and the effluent limitation program, water control officials know the pollutants and can identify the polluters. Thus the clean-up burden can be, and will be, put upon those who cause the pollution of our waterways. The permits also explain how the discharger is to comply with regulations and what state requirements he may also have to meet.

The legislation story is proof that action can be taken and that citizens can cooperate to enforce water pollution regulations. What happens at the local level can and should be the responsibility of each person who feels that guaranteeing a clean water supply is a worthy goal. By becoming and staying informed about your area's regulations regarding water pollution, you are in a better position to know what action you must take. If there are not enough pollution control measures in your town, find out what can be done to establish patterns of behavior that can produce cleaner water for your area. You and your family and friends can be the links that complete the chain to protect us all from polluting our waters.

The pages that follow provide you with specifics that will enable you to "JLP." Those letters represent three important words in our battle against pollution of any kind. JLP means Join, Learn, and Practice. JOIN ecology and nature groups, LEARN what legislation has done and can do to correct water pollution, and PRACTICE water pollution prevention and water conservation as a concerned individual.



JOIN ecology and nature groups. These groups need people who want to help preserve the environment. Their publications serve to keep people informed about what has been done, what is being done, and what needs to be done. Many groups have drives and campaigns for specific projects. These campaigns may involve writing to representatives, attending demonstrations, or contributing donations. Many use their donations or dues to maintain a lobby in Washington, D. C. in order to influence federal legislators. Your teacher can identify some groups for you to contact. You can also ask the Environmental Protection Agency in your state for information concerning local action groups.



LEARN what the federal government has been, is, and will be doing to correct water pollution. You may wish to write to:

Federal Water Pollution Control Administration
Department of the Interior
633 Indiana Avenue, N. W.
Washington, D. C. 20240

Environmental Protection Agency
Waterside Mall
4th & M Streets, S. W.
Washington, D. C. 20460

PRACTICE these Do's and Don't's, and you can limit the amount of water pollution that you yourself may be causing. Put your knowledge into action, for pollution control does mean avoiding the practices which cause problems. The list is not complete. What strategies would you like to add to the list?

DON'T	DO
1. Wash down the drain or flush down the toilet any solid wastes which can be disposed of in the garbage.	1. Drain oil from cars, power lawn mowers, and snow blowers into cans and either put the oil into the garbage or take it to a gas station which saves oil for reprocessing.
2. Use laundry and dishwashing detergents which contain polluting phosphates and nitrates.	2. Write to the Department of the Interior, Federal Water Quality Administration, Washington, D. C. for an up-dated list of the phosphate content of various detergents.
3. Use pesticides that can pollute. Some chemicals remain poisonous for a long time.	3. Avoid the use of all pesticides around the home. If this is not possible, buy the type which decomposes after doing the job.
4. Waste valuable supplies of clean water.	4. Keep plumbing fixtures in good repair. Use only as much water as you need.
5. Allow the soil from your home to erode and be washed away into a sewer.	5. Protect the soil around your home from erosion by planting ground cover or grass.
6. Litter waterways, beaches, or streets, since much of this material can travel to the nearest lake, stream, or river through the sewer system.	6. Keep all refuse to put into a litter basket or the garbage.
7. Buy products that cause water pollution problems, such as colored facial and bathroom tissues. These contain dyes which often are not removed by sewage treatment and stay in the water.	7. Purchase products in biodegradable or recyclable containers.
8. Remain unaware of water and waste water treatment technologies.	8. Arrange a visit to your local water company and the sewage treatment plant. See for yourself how cleanup technology is working in your area.
9. Expect pollution problems to be solved without community cooperation and financial support.	9. Support antipollution legislation and worthy bond issues for clean water.
10. Allow yourself to be politically inactive.	10. Communicate with elected and appointed officials about pollution clean up and pollution control. Let them know your views.

SECTIONS OF THE UNIT	STUDENT RESOURCE BOOKLET	COMPONENTS TO COORDINATE WITH RESOURCE BOOKLET		
		Audio-Visual Materials	Ecomaster Activities	Extension Activities
Water Use and Abuse	**Preface to the Unit**	**Filmstrip 1** Water, The Abused Servant of Man **Audio Cassette, Side A** **Overhead Transparency** Water Use	**Worksheet 1** The Effect of Phosphates and Nitrates on Pond Algae **Worksheet 2** How Microorganisms in Water React to Soaps and Detergents **Worksheet 3** The Effect of Sewage on Microorganisms	**Activity Card 1** Water Use in the Home
Pollution: Causes and Some Effects	**Riverview**		**Worksheet 4** Water Pollution Inquiry Questions **Worksheet 5** Water Pollution Inquiry Answer Sheet **Worksheet 6** Analyzing Riverview **Worksheet 7** Investigating Your Own Community	**Activity Card 2** Water Pollution Opinion Poll
Pollution: Interpreting Your Experiments	**A Healthy Waterway** **An Unhealthy Waterway**	**Blank Overhead Transparencies** **Overhead Transparencies** Life in a Healthy Waterway Life in an Unhealthy Waterway		**Activity Card 3** Water-borne Diseases **Activity Card 4** Succession on a Microscope Slide **Activity Card 5** The Effect of Dissolved Salt on Aquatic Plants
Protection: Technology at Work	**Cleanup Technology** **Effects of Certain Other Pollutants** **Lake Tahoe**	**Overhead Transparency** An Ideal Tertiary Sewage Treatment Plant **Filmstrip 2** Lake Tahoe—Then and Now **Audio Cassette, Side B**	**Worksheet 8** Removing Phosphates from Sewage Water	**Activity Card 6** Carbon Absorption **Activity Card 7** Constructing a Tertiary Sewage Treatment Plant
Protection: It's Everybody's Job!	**The Role of the Individual**		**Worksheet 9** The Riverview Hearing	**Activity Card 8** Phosphate Content Survey